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INVESTIGATION ON THE EFFECT OF FLYASH ON TENSILE, FLEXURAL AND IMPACT STRENGTH OF HYBRID COMPOSITE MATERIAL

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ABSTRACT

In the development of materials, the main objective is to reduce the weight and to have maintenance free materials with good mechanical properties these requirements are fulfilled by composite materials. In this work, carbon/abaca/kenaf fiber is fabricated by fly ash 3%, 4% and 5% mixed with epoxy resin. The mechanical characterization of the prepared composite materials are investigated experimentally. The low-velocity impact tests are performed by Charpy test method and tensile test and flexural test are performed by using a universal testing machine. The impact contact force and the tensile strength are accurately estimated using the experimental analysis method. The result showed that 3% fly ash composite had more strength compared to 4% and 5% fly ash composite.

KEYWORDS: Carbon Fiber, Abaca Fiber, Kenaf Fiber, Fly Ash & Mechanical Properties

Original Article

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INTRODUCTION

Fly ash has been gaining popularity in the field of construction because of its low density, easy availability and low cost. During the past decade fly, ash has extended its reach in the composite materials. Fly ash reinforced glass fiber epoxy composites have an increase in compressive strength with increase in fly ash. Similarly carbon fiber epoxy composite with fly ash reinforced composite increased impact strength due to energy absorbed by the fiber. The tests like flexural test and impact tests were conducted in order to find the strength of the material that has been fabricated [1].

Composite materials containing varying amounts of the coil and fly ash were prepared using compression molding method. Lot of research work investigated natural fiber reinforced containing polymer matrices. The natural fiber are obtained from plants like stems of banana, bamboo, kenaf, hemp, sugarcane, etc., and also leaves of abaca, sisal, and fruits of coconut, palm, and betle nut. The plants and trees of above-mentioned sources of fibers are cultivated in equatorial and tropical regions. The fibers extracted from the sources are mostly used as reinforcement element in composite materials [2]. During the recent decades, the use of natural fibers in composite materials has increased in sustainable interest. These fibers may be combined with fly ash and thermo -set plastic polymers to create NFC [3-4]. In the past, natural fibers having mineral content within the asbestos group was used extensively to produce composite materials. However, these are nowadays avoided due to the association with health issues like carcinogenic through inhalation or ingestion. Hence they are banned in many countries [5-6].

Three ratios of 50:50, 65:35, and 70:30 epoxy glass fibers, fly ash respectively were used to make the specimens. The volume of the fly ash is kept constant is the entire three specimens i.e. 6% by weight. Then different tests and the test results exhibit better mechanical properties on the 65:35 compositions [7-10].

Carbon fibers are available commercially with its tensile modulus ranging from 207 GPa to 1035 GPa. Generally the lower modulus fibers have low density and cost, but higher modulus fibers have high density and cost. These carbon fibers are used in the aerospace application because of high performance. Some of the advantages compared to other fibers are high strength, light weight, high modulus of elasticity, low thermal coefficient of expansion, high thermal conductivity and high fatigue strength. Some of the disadvantages of carbon fibers are low strain rate, low impact strength, high electrical conductivity and costly. A strength of the carbon fiber increased due to fly ash depends upon the fiber planes and connected through the Vander walls bond which exhibits the anisotropic mechanical properties [11].

In this paper, a hybrid composite material prepared using varying composition of fly ash. The other components are the hybrid composite material as Carbon/Kenaf and Abaca. The resulting composite materials are tested to characterize.

EXPERIMENTAL WORK

Materials and Methods

The composite material was produced using hand layup technique. The reinforcement materials were composed of abaca/ kenaf fibers and carbon fibers in woven roving mat form. Epoxy resin provided the necessary binding as well as acted as the matrix material. Abaca/kenaf fibers were selected as reinforcement material because of its availability and biodegradable characteristics these were procured from local natural fiber processing unit in Chennai. To remove moistures from the natural fiber it was dried under the sunlight for 3 days. The carbon fiber of 0.007 mm diameter and 210 GSM fibers used to make the mat and size measured as 300 mm long X 300 mm wide. Commercial grade Sodium Hydroxide (NaOH) was purchased from the local supplier. Ethanol, distilled water was purchased from chemical lab Pliogrip, Chennai, Tamil Nadu. Epoxy resin LY556 was selected as the resin and the hardener HY 951 was mixed in the ratio of 10:1. The combination of resin and hardener provided the dual purpose of acting as binding agent and also matrix element in the hybrid composite material. The fly ash is mixed with the resin continuously for spreading of the fly ash throughout the resin. The fly ash is weighed according to the required weight percentage. The percentage that is used in these fabrications is 3%, 4%, 5% respectively. The layer sequence of the composite is shown in Figure 1.

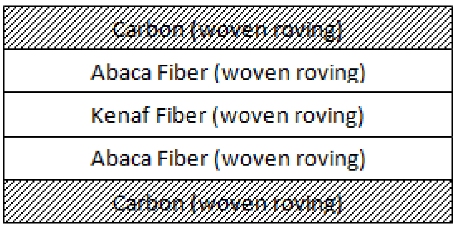

Figure 1: Schematic Diagram of Composite Material

Preparation of Test Specimen

The cutting of the materials is the next step in the process. The material that is fabricated is cut as per the standards of ASTM (American Society for Testing of Materials). The materials are cut from the slab in the ASTM standards for all the tensile, flexural and impact testing. The standard for the tensile testing is ASTM D638 and the

standard of cutting for the flexural test is ASTM D790 and the cutting standard for the impact strength is ASTM D256. The cutting of the material is done by water jet cutting.

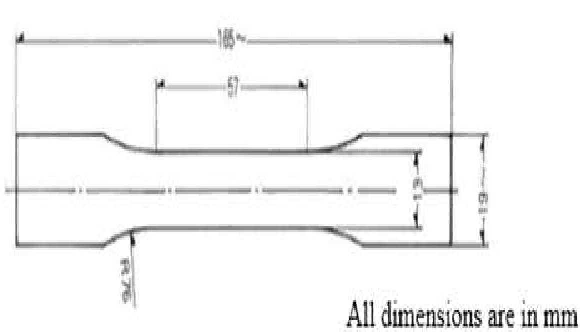

Figure 2: Schematic of Tensile Test Specimen

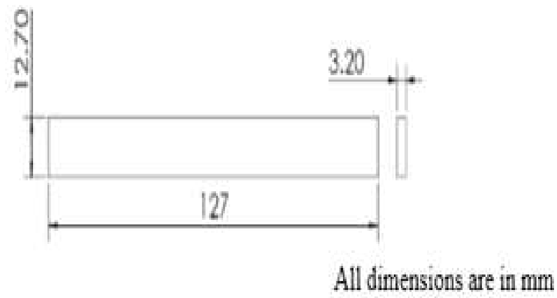

Figure 3: Schematic of Flexural Test Specimen

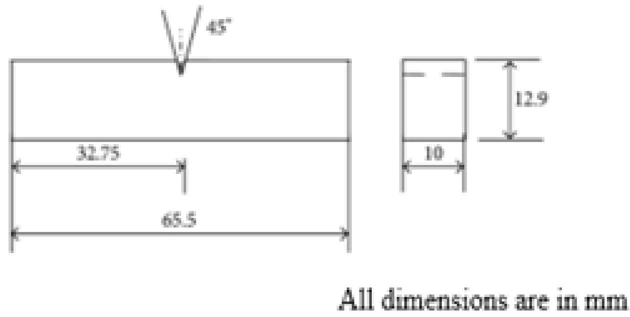

Figure 4: Schematic of Impact Test Specimen

The above figures 2, 3 and 4 show that the schematic figure of test specimen as per ASTM standards. The tests were conducted by using Universal Testing Machine

RESULTS AND DISCUSSIONS

Tensile Strength

The tensile strength of three different composite samples produced for this research work is given in Table 1. Tensile strength results of the composites are followed downtrend line depicted in figure 5. Sample graph for stress vs. strain and load vs displacements are shown in figure 6&7.

Table 1: Tensile Test Result of the Fly Ash Reinforced Fibre Composite Material

Sl. No	% of Fly Ash	Tensile Strength in N/mm2
1	3	216
2	4	168
3	5	54

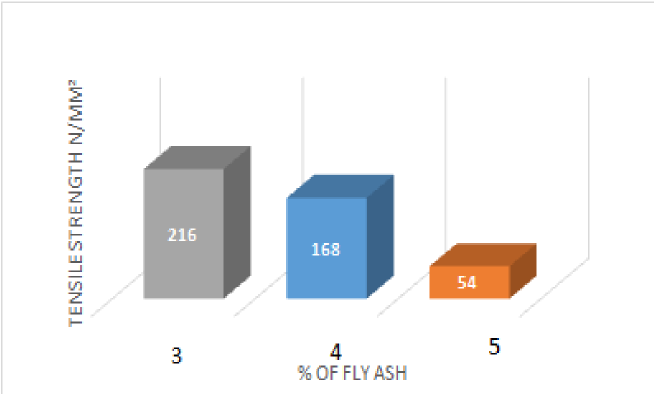

Figure 5: Tensile Strength of the Composite Materials

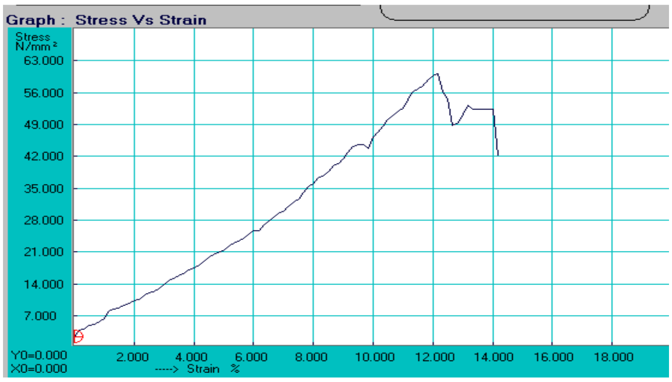

Figure 6: Sample Graph of Stress Vs. Strain

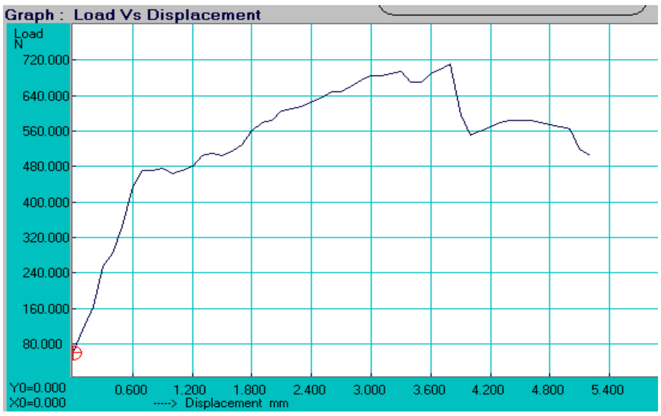

Figure 7: Sample Graph of Load Vs Displacement

Flexural Strength

The increase in the flexural strength of the abaca-kenaf-carbon fiber is attributed with the improvement in its flexural strength after minimum 3% fly ash composition shown in table 2. The inclusion of carbon fiber also contributed its share of raising the overall flexural strength of the produced composite material. The oven roving nature of the fiber drastically improved the compressive strength of the hybrid composite material which resulted in improving its flexural strength. Increase in fly ash of the composites is followed downtrend line depicted in figure 6.

Table 2: Flexural Test Result of the Fly Ash Reinforced Fibre Composite Material

Sl. No	% of Fly Ash	Flexural Strength in N/mm2
1	3	354
2	4	166
3	5	90

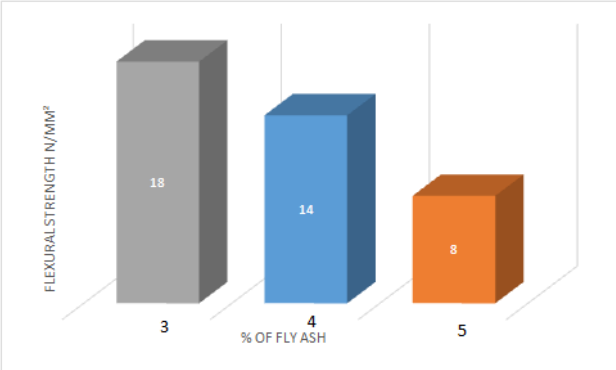

Figure 8: Flexural Strength of the Composite Material

Impact Test

Experimental results are shown in below table 3. Composite filled by 3% exhibited maximum impact energy of 18 Joules. When compared with other filled composite materials. Impact results of the composites are followed downtrend line depicted in figure 7.

Table 3: Impact Test Result of the Fly Ash Reinforced Fibre Composite Material

Sl. No	% of Fly Ash	Impact Energy in Joules
1	3	18
2	4	14
3	5	8

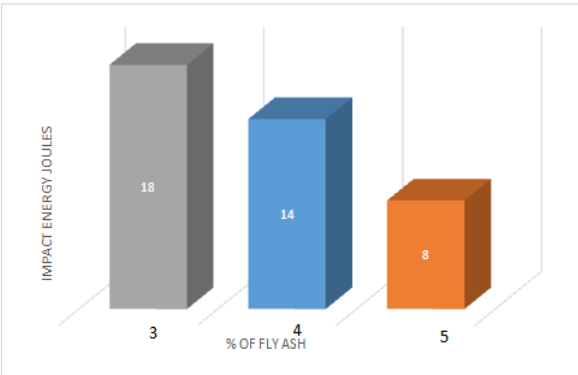

Figure 9: Impact Strength of the Composite Material

CONCLUSIONS

The tensile, flexural and impact tests were carried out in the fly ash reinforced resin carbon/abaca/kenaf fiber composite materials with 3%,4% and 5% fly ash percentages. The specimens were cut and tested at the different test as discussed above. It can be concluded that as the weight fraction of fly ash increases the overall performance of the

composite decreases. The following conclusions were drawn on the test response of the fly ash reinforced fiber composite materials.

- The tensile strength of the produced composite material is decreased with increased in fly ash.
- The flexural strength of produced composite material decreased with increase in fly ash.
- The impact strength of produced composite material decreased with the increase in fly ash.

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